Claims

What is claimed is:

1. A fuel injector comprising:

an injector body defining a nozzle outlet and a needle control passage;

a needle valve member positioned in said injector body and including a closing hydraulic surface exposed to fluid pressure in said needle control passage, and being movable between an open position in which said nozzle outlet is open, and a closed position in which said nozzle outlet is blocked;

an orifice member positioned in said injector body and defining a flow passage with relatively restricted flow area, and being movable between a first position and a second position;

said needle valve member displacing fluid through said flow passage when moving toward said open position; and

said needle control passage having a relatively unrestricted flow area to fluid flowing toward said closing hydraulic surface over at least a portion of movement of said needle valve member between said open position and said closed position.

2. The fuel injector of claim 1 wherein said orifice member defines a portion of said needle control passage.

3. The fuel injector of claim 2 including a compressed spring operably positioned in said injector body to bias said orifice member toward one of said first position and said second position.

4. The fuel injector of claim 3 wherein said compressed spring is also operably coupled to bias said needle valve member toward said closed position.

5. The fuel injector of claim 4 wherein said spring is compressed between said needle valve member and said orifice member.

6. The fuel injector of claim 2 wherein said orifice member is a variable area valve member;

said flow passage fluidly connects an upstream portion of said needle control passage to a downstream portion of said needle control passage when said variable area valve member is in said first position; and

said needle control passage has a relatively unrestricted flow area when said variable area valve member is in said second position.

7. The fuel injector of claim 6 wherein said variable area valve member defines at least a portion of at least one additional flow passage; and

said relatively unrestricted flow area includes a combination of said flow passage and said at least one additional flow passage.

8. The fuel injector of claim 7 wherein said at least one additional flow passage includes an annular flow area between said variable area valve member and said injector body.

9. The fuel injector of claim 7 wherein said at least one additional flow passage is defined by said variable area valve member.

10. The fuel injector of claim 7 wherein said injector body includes a valve seat; and

said variable area valve member being in contact with said valve seat when in said first position, but being out of contact with said valve seat when in said second position.

11. The fuel injector of claim 10 wherein said valve seat is one of a flat valve seat and a conical valve seat.

12. The fuel injector of claim 2 wherein said orifice member includes an opening hydraulic surface exposed to fluid pressure in an upstream portion of said needle control passage.

13. The fuel injector of claim 1 wherein said orifice member remains stationary when said needle valve member moves from said closed position toward said open position.

14. The fuel injector of claim 1 wherein said orifice member remains stationary when said needle valve member moves from said open position toward said closed position.

15. A method of injecting fuel, comprising the steps of:

opening a nozzle outlet slowly at least in part by displacing fluid, which is caused by movement of a needle valve member, through a restricted flow passage defined by an orifice member; and

closing said nozzle outlet quickly at least in part by displacing fluid toward a closing hydraulic surface of said needle valve member through an unrestricted flow passage defined at least in part by said orifice member.

16. The method of claim 15 including a step of biasing said orifice member toward a first position; and

biasing said needle valve member toward a closed position.

17. The method of claim 16 wherein said biasing steps are accomplished with a common biaser.

18. The method of claim 15 wherein said opening step includes moving said orifice member from a first position to a second position.

19. The method of claim 15 wherein said closing step includes a step of moving said orifice member from a restricted position to an unrestricted position.

20. The method of claim 15 including a step of increasing fuel pressure at said nozzle outlet for a majority of time between said opening step and said closing step.